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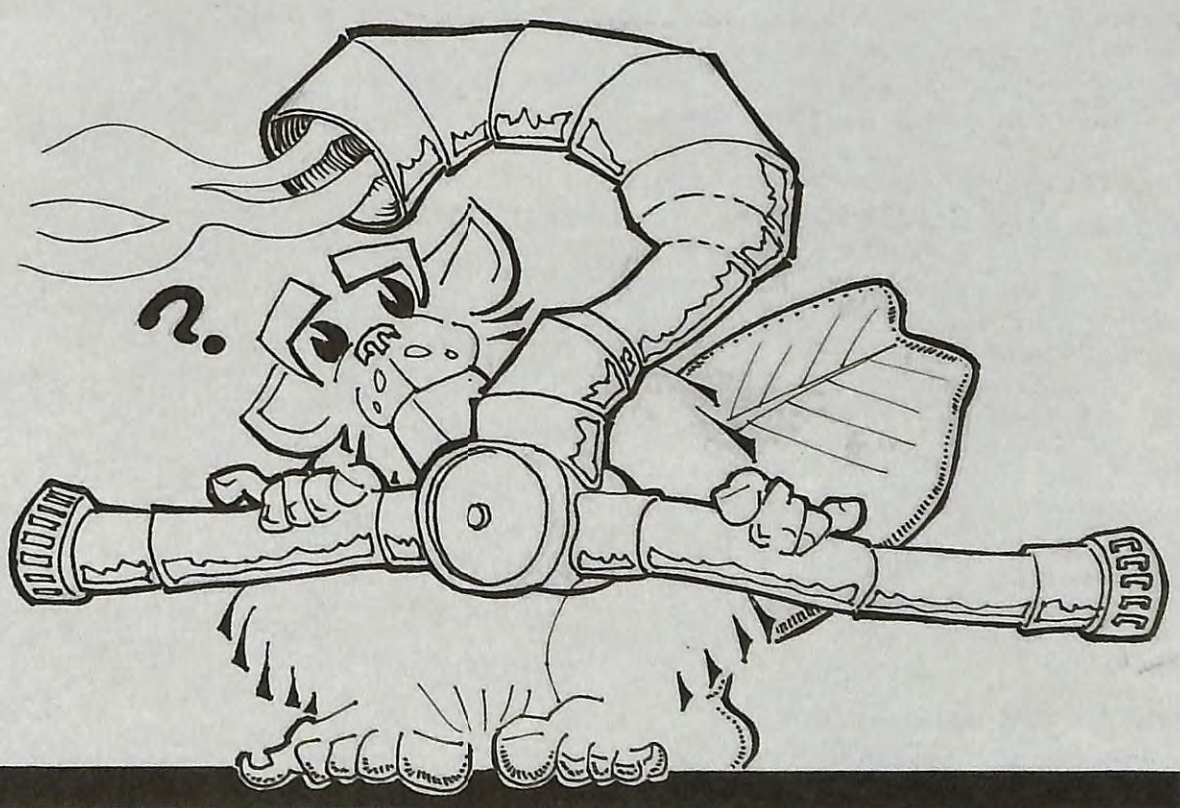
Fanless Heat Recovery Ventilators



From the Editor . . .

When I was at university many years ago, I was doing research for a project on human comfort indicators. My professor knew of a scientific research paper that dealt with the subject and which might be of help. It was written by scientists in Russia, then part of the Soviet Union, and obviously during the height of the Cold War.

The scientific paper was interesting. The preamble on the first page of the paper was a statement about the wonders of the Soviet socialist revolution, how it engaged in scientific investigations, how Marxist thought was vital to the determination of scientific truth, etc., etc. After the set piece paying regard to the political ideology was out of the way, the authors could get down to the actual subject matter. That kind of political preamble was common for papers that had nothing to do with social, economic or political subjects, but were dealing with purely technical subjects.

What does that have to do with Canada in 2007 and with Canadian builders? Unfortunately, recent political shifts in North America (both Canada and the US) seem to have disturbing parallels to the bad old days of the Soviet Union.

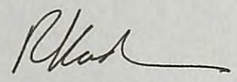
We have seen numerous reports of the suppression of scientific data and reports by scientists at various agencies and institutions in the United States. It seems that scientific data and research that is inconvenient for the power brokers, on whatever subject -- be it climate change, stem cell research, human illnesses, environmental impacts of specific activities--has been suppressed or scientists have been instructed by outsiders to make changes.

While we may feel smug that it is only happening with the current ideologically driven US administration, we have parallels in Canada. It seems that the current Canadian government is following in the Republican footsteps as similar situations have happened here. Scientists have been forbidden to speak out on topics in their field of expertise, even if it is on their own time. Research has been curtailed – the latest is the news that CMHC has backed out of doing fundamental technical building research, even if it responds to identified needs.

Even at the purely technical level many government departments can't take action, do research or make a decision on strictly technical issues without having a policy analyst do a review and approve. In the Soviet Union those folks were referred to as the political commissars. It seems we have those today in the Canada of 2007.

Lest you think this is an insignificant issue that is only of interest to committed political watchers or those of a certain persuasion, remember that decisions that affect our business are made by politicians. Land use decisions obviously involve a great measure of political discussion. Decisions are often made not necessarily on the basis of technical merit, but as a result of whims, misconceptions or prejudices of those with access to the power brokers.

However, there are also many technical issues dealt with by codes and standards that are subject to seemingly irrational action. There have been decisions taken in recent years where actions were taken or at least seriously contemplated purely on the basis of some political desire to 'deregulate' or 'simplify' the industry without any serious technical merit. When an organization with the technical depth and background such as CMHC has been forced out of technical research, when other departments must pass everything, including highly technical issues past the filter of "policy" analysis before taking action, it should be a great concern for all in the industry.



Richard Kadulski,
Editor

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Fanless Heat Recovery Ventilators

Ventilation is key to maintaining good indoor air quality. Building codes are becoming more stringent in their requirements for ventilation. However, how best to provide the required air change in an effective and economical way remains a challenge for many builders and designers. For many homeowners, there is the added concern about energy costs associated with ventilation because heating costs associated with ventilation and air leakage can be a significant percentage of total energy costs in a typical home.

There are many ways to provide an effective ventilation design that does not add excessive costs. Perhaps the best known and most widely used ventilation approach today is the heat recovery ventilator (HRV) that offers air change with heat recovery. HRV systems are significantly more costly than non-heat recovery ventilation systems, although the extra cost is offset by the savings on energy bills.

For some, the initial costs are a barrier to these systems being installed in new homes. For others, it is a misunderstanding about the objectives of ventilation, and how it is provided. There are still many who believe that opening windows, especially if on opposite sides of the house (to allow for "cross ventilation") will provide adequate air change in the house.

Fanless HRVs are becoming popular in some parts of Canada. Fanless HRVs offer the promise of heat recovery with lower installed costs than motorized HRVs. The challenge is that without a fan to move air, the airflows in these systems have to be achieved by the proper design and integration with the forced warm air heating system to generate the pressures that are required to move the air in and out of the house.

A study done by Bill Crist for Natural Resources Canada compared the two types of HRVs in terms of providing adequate ventilation as well as recovering heat. Twelve houses with heat recovery ventilation systems were studied. Eight houses had fanless HRV systems and four had motorized HRV systems. Measured airflows were compared to National Building Code (NBC) ventilation requirements.

All of the houses with the conventional motorized HRV systems met the essential requirements of the NBC. Only three of eight fanless heat recovery systems met the 2005 National Building Code requirements and were balanced within 10%. However, most of the fanless HRV systems would have met the code with some modifications.

Using better installation practices, fanless HRV systems are capable of meeting the Principal Ventilation (low speed) requirements for small- to medium-sized homes although none of the fanless systems in this study met the Total Ventilation Capacity (TVC) as installed.

Supplemental fans used with the fanless HRV systems exceeded the sound ratings required to be included as part of the TVC (1995 NBCC).

Additional observations that were noted in the study:

- There was no indication that any of the fanless systems had been balanced or had airflows measured (none of the HRV balancing dampers were locked in a fixed position).
- Flow measuring stations or other means of ensuring adequate and balanced airflows would be beneficial in all installations.
- There was no indication that duct designs were done on the fanless systems (the same size duct was used regardless of length or number of fittings). Some of the motorized HRV systems benefited from duct designs that were done prior to installation.
- Although the motorized HRV systems provided higher heat recovery than the fanless systems, fanless HRV systems do provide some heat recovery and do temper the outdoor air before it reaches the furnace (or air handler) heat exchanger.

Reasons for the fanless HRVs not meeting the Building Code requirements:

1. Installation Issues

Improper duct sizing:

- Ducts too small
- Duct length too long
- Too many fittings for the duct size chosen
- Location of HRV connections to the forced air duct system. This study found that there was a large variation in the static pressures observed at the HRV connections. Connections should be made as close to the main supply and return air plenums as possible.

Systems not balanced (dampers not locked).

- Five of the eight fanless systems were more than 10% unbalanced. One of the four motorized systems was more than 10% unbalanced.

2. Supplemental Exhaust Fans:

In all cases, the sound (sone) ratings for the supplemental fans were too high to comply with the requirement for fans in the 1995 NBCC although they would comply with the requirements of the 2005 NBCC.

Although fans with a sound rating of 2 sones are acceptable to the NBC, in BC, the BC Building Code sets a limit of 1.5 sones. However, we have noted that even 1.5 sones is too loud, and will generate noise complaints. In order to avoid noise complaints, fans should have a sound rating of 1 sone or less.

3. Manufacturers' Guidelines:

It would be helpful for the heating contractors to have better guidelines from equipment manufacturers regarding such things as:

- Realistic expected airflows. One manufacturer lists the "allowable airflow" as 200 cfm, but it is unlikely that this airflow would be achieved in a typical residential installation. Most manufacturers' brochures give no indication of expected airflows. Perhaps the fanless HRVs are more suited to small and medium sized houses – but there is little certainty based on manufacturer information.
- Flow vs Static Pressure curves showing the flow that can be expected with a range of available static pressures.
- Recommended total effective lengths for various duct sizes related to the available static pressure.
- Balancing damper levers that are more visible and less likely to be forgotten.

Comparison Of As Installed Fanless Heat Recovery Ventilation Systems With Motorized Heat Recovery Ventilation Systems prepared for Natural Resources Canada by William L. Crist, P.Eng.

Energy Performance of Fanless HRVs

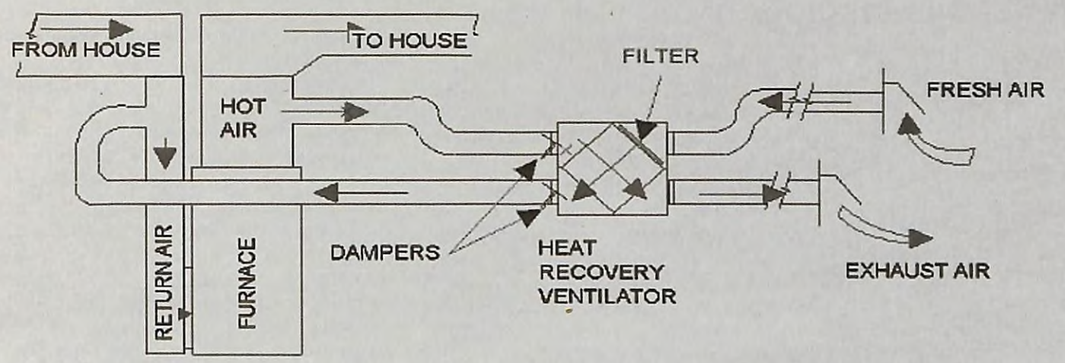
A big reason for using fanless HRVs is to provide better energy performance than can be achieved using a conventional exhaust-only ventilation system without heat recovery. The fanless HRVs do show respectable energy performance, but generally less than motorized HRVs. However, they do require the furnace fan to be running continuously, otherwise the heating only run times will not provide adequate air change.

Energy performance comparisons that were done in this study were based on temperature effectiveness, and do not take the furnace blower fan energy consumption or cross leakage within the HRV into account.

Fanless HRVs (as installed) had approximately 63% effectiveness (combining both firing and ventilation only modes). Motorized HRVs (as installed) had approximately 73% effectiveness (combining both firing and ventilation only modes). However, one of the motorized HRVs was a high efficiency double core unit so the results are slightly biased in favour of the motorized units.

The energy impact of exhausting hot furnace supply air is not included in the effectiveness comparisons. The "wasted heat" at the exhaust hood of the system will depend on such things as:

- HRV exhaust airflow
- HRV effectiveness
- Location (climate)
- Furnace plenum temperature (a function of the furnace temperature rise).
- Furnace oversizing. The more the furnace is oversized, the less it will operate in a firing mode. This means that it will not be exhausting at such high temperatures for long periods of time.



Typical Fanless HRV System

Fanless systems are usually installed in combination with forced air heating systems and use the furnace or air handler blower to provide the force needed to move air. Air is exhausted from the house through a duct connected from the hot air supply side of the air handler to the heat recovery ventilator. This expels a portion of the house air to the outdoors through the heat recovery core. Fresh air is brought in by connecting the heat recovery ventilator to the return air side of the air handler so that the air handler suction draws fresh air into the house through the heat recovery core.

Fanless HRVs typically do not have defrost devices (such as motorized dampers with sensors) which automatically defrost the core when needed. When outdoor temperatures are cold enough to cause ice build-up in the HRV, there is usually a call for heat from the furnace. The furnace then forces hot air into the HRV which reduces the potential for ice build-up within the core.

Typically the fanless HRV systems are designed to provide only 50% of the TVC requirement. Supplemental fans are required in the bathrooms and kitchen in order to provide contaminant removal and these fans can be sized to bring the house ventilation rate up to the TVC. Although the passive HRVs can be installed to provide the full Total Ventilation Capacity for the house, it is difficult to provide a control that will also ensure a flow in the 45 to 55% TVC range (as required by the Building Code).

This study was done in Alberta. It would be useful to look at the performance of fanless HRVs in various climatic locations across Canada with different combinations of furnace oversizing, plenum temperatures and exhaust air flow rates. This would provide a better indication of the energy performance of fanless HRV systems.

It should be noted that motorized HRV systems are more costly than fanless HRV systems. Based on interviews with Alberta heating contractors the cost of a motorized HRV system is approximately double the cost of passive HRV systems (with both systems connected to the forced air distribution system without extended exhaust ductwork). ☼

Recommendations for installing fanless HRV systems:

Heating contractors should assess the ventilation requirements of the house, and verify by design that a fanless HRV will provide adequate airflows. Supplemental fans should have appropriate sone ratings.

Duct design

- ☞ Locate the duct take-offs as close to the furnace blower as possible (the point with the highest static pressures)
- ☞ Keep the duct runs short and straight
- ☞ Use at minimum 6" ducts (depending on the duct runs and static pressure available). Airflows can always be dampered down but it is difficult to increase after installation.
- ☞ Install flow-measuring stations or use other means to ensure that required airflows are being provided and that the airflows are balanced.
- ☞ Balance the system and lock the balancing dampers. ☼

Reflective Insulation

There has been much confusion about the properties and proper use of foil-backed insulation products, especially for use below slabs. This has been aggravated by aggressive product salespeople.

Reflective vapour and air barrier products and reflective sheathing can, if properly installed, provide additional thermal resistance to wall and ceiling assemblies, however, for the thermal resistance to be achieved, the surfaces must face an airspace. The surface properties of the reflective material must remain unchanged. CCMC evaluates the thermal resistance of low emissivity sheet materials, but these have always been evaluated as part of a wall system with air spaces. The CCMC Product Registry has listings for a few assemblies using reflective materials, but these only apply to walls.

An airspace is needed on either side of the insulation in order to provide reflective thermal resistance. In the absence of an airspace, reflective foil bubble pack products provide a maximum of R-1.5 (RSI 0.26) assuming the bubbles remain intact and unperforated. Despite advertisements and comments made by manufacturers and salespeople, the thermal resistance of a 20-mm airspace with two reflective surfaces is R-3.46 (RSI 0.61) for wall applications.

A CMHC Research study on a comparative series of tests of slab insulation found that the bubble pack insulation provided little value when used in an under-floor slab application.

Unless otherwise proven by an accredited third-party testing agency against a recognized standard for the testing of such reflective materials, NRCan has recommended the following maximum effective thermal resistance values for foil-backed insulation products when they are modeled with the HOT2000™ software:

- R-1.5 (RSI 0.26) where the bubble layer is between two layers of foil without airspaces in front of the foil.
- R-3 (RSI 0.53) where the bubble layer is between two layers of foil with only one air space in front of the interior facing foil.
- R-3.5 (RSI 0.62) where the bubble layer is between two layers of foil with an air space in front of each foil or where the foil layer is between two clear layers of bubbles acting as air spaces.

Points to consider about reflective foil insulating products:

- There is no specific ASTM standard (American Society for Testing and Materials) applicable to reflective foil products on which to rely. Manufacturers generally extrapolate portions of various tests to show how the product might perform in the house. Unfortunately, these are comparable to other insulation products.
- Due to the very complex nature of evaluating reflective insulating products, they are best evaluated as part of an assembly (e.g., wall, floor, slab and ceiling). Unfortunately, very little third-party assembly testing has been done to date.
- The US Federal Trade Commission has explicitly stated that insulation manufacturers must label their products with its basic R-value for the materials involved. If the foil product is installed with an air space, then the FTC also allows a "system R-value" label to include added benefits of the reflective qualities. No such information has been found as yet on Canadian labeled products.
- Most of the heat loss in the average Canadian home is from conductive heat loss and air leakage (not including windows). However, for houses with in-floor radiant heating, little data for radiant heat loss versus conductive heat loss is readily available.
- Manufacturers and researchers of in-floor hydronic heating systems do NOT recommend anything but foam under-slab insulation. You will not find references to reflective type sub-slab bubble insulation products or foil-faced foam products in their manuals.

According to the Reflective Insulation Manufacturers Association (RIMA), "Reflective vapour/air barrier products and reflective sheathing can, if properly installed, provide additional thermal resistance to wall and ceiling assemblies. To do so, the surfaces must be faced with intervening airspaces and the surface characteristics of the reflective material must remain unchanged. The NRC has indicated that the thermal resistance of a 20-mm airspace with two reflective surfaces would be R-3.46 (RSI 0.61) for wall applications however, the absence of an airspace on either side of the insulation prevents any additional reflective thermal resistance. In such applications these products are expected to provide a maximum of R-1.5 (RSI 0.26) assuming the bubbles remain intact and unperforated."

Foil-faced bubble insulation has other characteristics that may influence why builders may choose to use the product, such as its flexibility, its air and vapour barrier characteristics or its ability to reflect solar radiation in cooling climates, however, these are not primary thermal issues.

To complicate the issue, similar claims are also being made for 'reflective' paints. Some manufacturers, although they acknowledge that there are no R-values for liquid coatings, nevertheless claim that they can produce "an insulation equivalent of up to R-19 to R-24".

Regrettably, there may be a kernel of truth to some of these claims, but it is important to recognize what it is and where it might apply. In cooling climates, the main concerns are for building overheating. Consequently efforts are made to reduce heat build-up in the building. The reason that so much of Mediterranean architecture involves white-washed buildings is that long ago it was realized that anything that helps reflect the sun's heat will reduce overheating of buildings.

In the southern US, where the major conservation effort is to reduce cooling loads, many similar strategies are being used. In a hot sunny climate, coatings that help reflect heat will definitely appear to provide an insulating value.

When a southern California or Arizona wall or roof is painted with a product that has a high reflective factor, it will function as if the building had some additional insulation added. In a northern climate, some industrial or agricultural buildings -- especially if they are uninsulated or poorly insulated -- may benefit similarly from such a treatment. That is where the claims are generated.

It is unfortunate that the marketers extrapolate the impact of performance improvements in such special cases and try to apply it across the board, as if the same results would happen anywhere under any circumstances. They are doing themselves a disservice, misleading consumers, and generating unnecessary confusion.

In a northern climate, such as anywhere in Canada, reflective products may only have limited benefit during the summer cooling season, which is quite short. At our latitudes, heating is dominant. The sun in winter is low and has a low intensity, so overheating might only occur through windows, and in those conditions, reflective products have limited benefits.

Contrary to claims on some manufacturer product literature, their 'reflective' coatings do not "outperform 4 inches of foam insulation".☼

Wall System With Low Emissivity Sheet Material And Furred Air Spaces

When the low emissivity sheet material is installed in the wall system, the effective R-value of this material in combination with the air space and the furring used to create the air spaces will account for about 26% of the thermal resistance of the wall, while the low emissivity material itself will account for only about 5%. (The R-value of the material is in the order of 1.03.)

Most of the heat transfer through a wall assembly with a low emissivity sheet material and furred air spaces is conductive; radiation contributes only about 10%. These percentages will vary depending on:

- the wall design,
- the low emissivity sheet material used,
- the way the material is installed and
- the size of the air spaces.

The contribution of the assembly of low emissivity material, air spaces and furring strips to the thermal resistance of the wall system will also vary depending on:

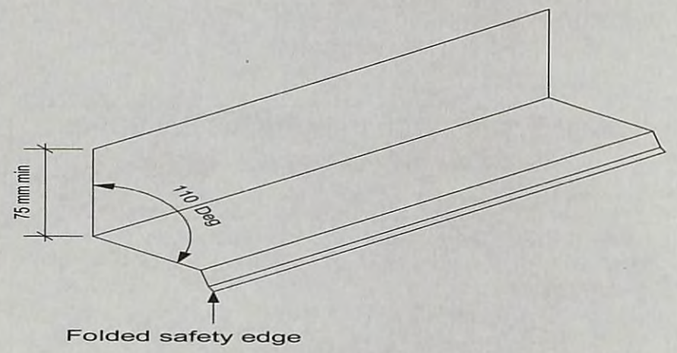
- the temperature difference across the assembly and
- the convective heat transfer mechanism within it.

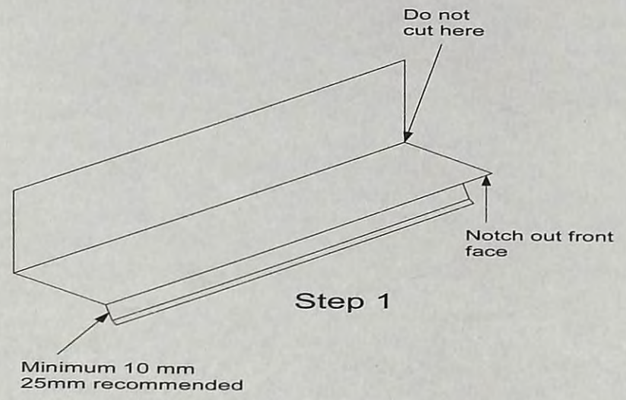
Thus, the thermal performance of each wall system will be unique to that wall system. The thermal resistance cannot be extrapolated to any other wall design without a complete engineering analysis of the wall system, using the detailed test results of the reference wall as benchmark data. Similarly, each low emissivity sheet material needs to be tested individually to properly identify its physical properties (e.g., emissivity, thermal resistance, water vapour permeance, tensile strength, etc.).

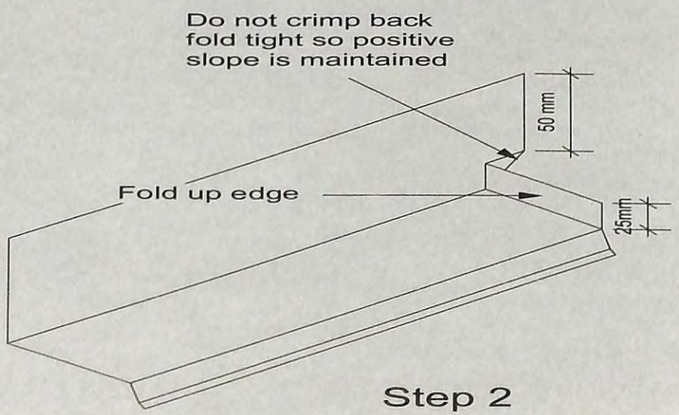
CCMC has a report on a system R-value on its web site: *http://irc.nrc-cnrc.gc.ca/pubs/ci/v4no2/v4no2_7_e.html*.

An interesting report by CMHC on the **Comparison of Under-Floor Insulation Systems** can be found at: *www.cmhc.ca/od/?pid=63728*. The bubble insulation foil referenced in this report is the type that has the reflective foil between two clear layers of bubbles.

Flashings and the 2005 National Building Code



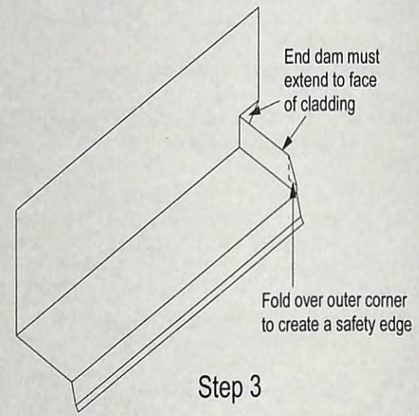




The current edition of the NBC has set out more stringent requirements for flashings, especially window and door head flashings. Along with the introduction of mandatory rainscreen detailing, there has been a lot of concern among builders about how to comply with the new requirements. We are presenting some window head flashing with end dam details that meet requirements of NBC 9.27.3.8.

The drawings are intended as a general reference guide only. Project and site specific factors, including climate, exposure, complexity, aesthetics, etc., must always be taken into consideration.

The warranty providers in BC worked together to develop a set of details that are intended to provide a practical reference guide for assembling the building envelope in wood frame construction. The information represents current wood frame building practices in the BC coastal region and has been reviewed by a spectrum of industry participants.



Warranty Provider Accepted: A Reference Guide Of Typical Rainscreen Wall And Window Details

In British Columbia, the Homeowner Protection Act requires that residential builders be licensed and makes third-party warranties mandatory on new home construction throughout the province. Warranty providers active in the single family dwelling market that participated in the development of these details include:

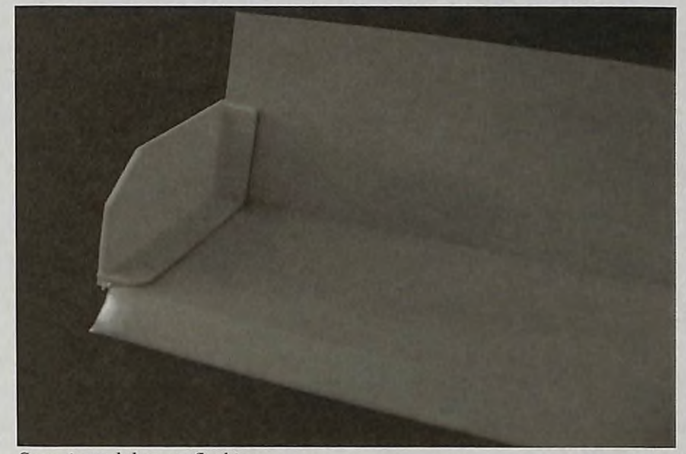
www.nationalhomewarranty.com
www.travelersguarantee.com
www.lombard.ca

Manufactured End Dams

A BC company has developed an alternative way of providing an effective end dam on flashings. They have a vinyl end cap that snaps onto the end of a flashing to provide the required upstand at the end, avoiding the need for a lot of cutting and crimping of sheet metal. Because it is a preformed unit that fits into a sloped flashing, it ensures there is no water penetration as it allows water to be shed, and minimizes the chances of installing a flashing that deformed to provide a level ledge to collect water.

The principals of the company have a background in construction, having installed vinyl, wood and cement-board siding, so their products have been job site tested. They identified a way of making their job easier, and at the same time providing failsafe ways of improving rain screen siding applications by the creation and manufacturing of 'rain-improved' exterior construction products.

Other products include rainscreen clips for vinyl siding, a vented starter strip that provides a convenient, durable solution for installing the first course of siding on a rainscreen wall, and a variety of mounting brackets that provide a flat surface on which to mount exterior lights, plugs and other fixtures but that also prevent water intrusion around the opening.



Snap-in end dam on flashing

For information:
Raindog Building Products
www.raindoginc.com
Phone: 604-230-3069

Flashing Design

Flashings are a seemingly minor but all-important element in building detailing. Their purpose is to divert water away from the building surface. Metal flashings are typically used at horizontal joints and material transitions to shed water away from building surfaces.

The look of flashings irritates designers, who would rather have clean unbroken surfaces.

Manuals such as CMHC's Best Practice guides, building codes and other technical documents stress their importance, but do not provide specific requirements for the flashing design.

A study by Afarin Maleki at Ryerson University showed that profiles with horizontal projection of ½" (15 mm) or less will divert 50% of the water at best. To shed water efficiently, metal flashing must have a horizontal projection of 1" (25 mm) or more and the drip-edge angle must be between 30° and 60°.

Often, sealant is applied to the joint between the metal flashing and the vertical surface, however, the application of sealant can reduce the efficiency of the flashing. Where the sealant is applied behind the flashing, the profiles should have a drip-edge length of at least 30 mm to perform efficiently.

Impact of Sealant on the Water-Shedding Performance of Metal Flashing *by Afarin Maleki, Ramani Ramakrishnan and Hitesh Doshi, Department of Architectural Science, Ryerson University. Paper presented at the 11th Canadian Conference on Building Science and Technology, Banff, 2007*

Technical Research Committee News

Canadian Home Builders' Association

Building Code Objectives

The National Building Code of Canada defines the objectives of the Code as being

- safety,
- health,
- accessibility for persons with disabilities,
- fire and structural protection of buildings.

Two new objectives have been proposed: one for *water-use efficiency* (which exists in some provincial codes), and the other dealing with *psychological well-being* (having to do with the need for natural daylight in bedrooms and living areas of homes).

CHBA has made a presentation to the Executive of the Canadian Commission on Building and Fire Codes (CCBFC) recommending that they develop an assessment framework before considering proposals for new objectives.

CCMC Evaluation Reports

The CCMC (Canadian Construction Materials Centre) Registry provides technical opinions on the suitability of a product for its intended use. It is used by designers, builders and building officials to determine the suitability of products and systems. Building officials support the use of CCMC evaluations as a basis for determining the acceptability of products within the context of building code requirements. In Ontario, CCMC is the only organization designated as a materials evaluation body for the purposes of supporting Minister's Rulings on innovative materials, systems and building designs under the Building Code Act.

CCMC opinions often relate to the equivalency of a product to the requirements of the National Building Code of Canada and to provincial codes. Where a product is so new that no appropriate standard exists, CCMC develops a set of technical criteria in consultation with experts from NRC and other organizations.

The Evaluation Reports and Evaluation Listings specify the ways in which the products are to be used for the evaluation to be valid. Each year, CCMC requires the proponent to affirm that the product has not been modified in any way. Every three years, the product is re-evaluated, and full or partial tests are required if necessary.

For assessment purposes, the manufacturer must also submit a copy of the in-plant manufacturing quality control manual for the current production line to CCMC. Information on production quality control (problems encountered and solutions applied) is also required at re-evaluation. Evidence of poor performance of a product or failure to conform to evaluation criteria may result in cancellation of the Evaluation Report or Evaluation Listing.

There has been some confusion among building officials about the current CCMC evaluation listings. Many evaluation reports and listings in the current registry show "re-evaluation due" dates that are past. CCMC is currently in the process of re-evaluating product listings, and updating code references to the new 2005 NBC. In the interim, until the evaluations are brought up to the 2005 NBC references, the evaluations remain valid for the conditions under which they were originally published, even though most reference the 1995 NBC.

More information about CCMC Product Evaluation and the registry of products can be accessed on-line at: *http://irc.nrc.gc.ca/ccmc*

. . . until the evaluations are brought up to the 2005 National Building Code references, the CCMC evaluations remain valid for the conditions under which they were originally published, (even though most reference the 1995 NBC).

"Green" Labeling

CHBA has been involved in energy-efficiency labeling for many years and recognizes that labels can provide new-home builders with opportunities. However, concerns have been expressed because in some regions proponents of these labels are also pushing them to be introduced as regulations. For example, in BC the government is working on a "Green" Building Code.

CHBA has concerns when upgrades are pushed through the regulatory framework rather than through market-driven approaches. Especially if the upgrade standards are introduced prematurely, there could be problems with their implementation. CHBA intends to document what is taking place across the country and identify the problems associated with green labels used as regulations.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
Canadian Home Builders' Association, Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

BC Green Building Code Initiative

The BC Office of Housing and Construction Standards is the lead agency on development and implementation of a "Green Building Code." The code was announced by the BC government as part of its commitment to reduce greenhouse gas emissions related to buildings and construction.

The green building code project team's goals are:

1. to identify and remove barriers within provincial codes and regulations
2. to identify and propose new provisions for green buildings regulation
3. to support implementation through an administrative framework, education and training.

The intent is that the green buildings regulation will be results based and flexible for industry and will consider a range of sustainability areas such as:

- Sustainable sites – land use, storm water management; servicing infrastructure;
- Water conservation – low-consumption fixtures, re-using waste water;
- Energy – energy efficiency for buildings, on-site renewable energy; energy efficient devices; community energy planning;
- Materials and resources – re-using existing buildings; reducing construction waste; using sustainable building materials;
- Indoor environment – enhancing air quality; reducing air contaminants (e.g. low-emission adhesives, sealants and finishes);
- Innovation and design process – facilitating green building through administrative processes

Industry, professional, community representatives and the general public have been invited to be involved through a public review of all proposals which is scheduled for the fall of 2007, and through an industry advisory committee with representation from key associations.

For more information contact the Building & Safety Policy Branch: e-mail: *building.policy@gov.bc.ca*

www.housing.gov.bc.ca/building

Radon

Health Canada conducted a consultation over the last two years which has resulted in recommendations that the safe limit for radon be dropped from 800 becquerels per cubic meter to 200 becquerels per cubic meter to bring Canada in line with most other developed countries.

CHBA supports this move as radon is clearly a very serious health concern as documented in a CHBA paper released previously. However, at the last minute Health Canada has proposed a further cut from 200 becquerels to 100 becquerels for new houses. CHBA has written to the Minister of Health in support of the move to 200 becquerels but requesting that the department reconsider the proposal of the further cut to 100 becquerels. A final decision is expected soon. Regardless of the outcome, the industry will need to accommodate the new requirements.

Building Code Interpretation re Stucco Lath

Stucco Lath Specifications, Table 9.28.4.3. 2005 National Building Code of Canada (and 2006 BC Building Code)

For buildings that fall under the scope of Part 9 of the NBC, Article 9.28.4.3. specifies a minimum diameter for wire that is to be used for welded or woven wire. This requirement reflects traditional stucco lath manufactured with round wire. Today stucco lath that uses wire with a rectangular section, as compared to the common round wire is also being used.

The BC Office of Housing and Construction Standards has issued an opinion that welded stucco lath using rectangular wire with an equivalent cross-sectional area to the specified diameter in Table 9.28.4.3 meets the Building Code's intent and objectives. It is not the intent of Article 9.28.4.3 to preclude the use of wire other than round wire, so the Building Policy Branch will be recommending that Table 9.28.4.3 be amended to include the addition of equivalent cross-sectional areas to that of the diameter wire specified.

Impact of Window Properties on Energy Performance

Windows are a key component in all building types. They have a big impact on the overall energy consumption of a house. Generally, because of their significant area and low R-value, windows need to be considered as thermal holes in the building envelope.

In terms of energy performance, windows play a dual role, allowing solar gains to reduce heating loads during the heating season or overheat the building during the cooling season. Studies have shown that, in a typical Canadian house, heat losses through windows during the heating season can account for about 35-40% and even up to 50% of the total heat losses.

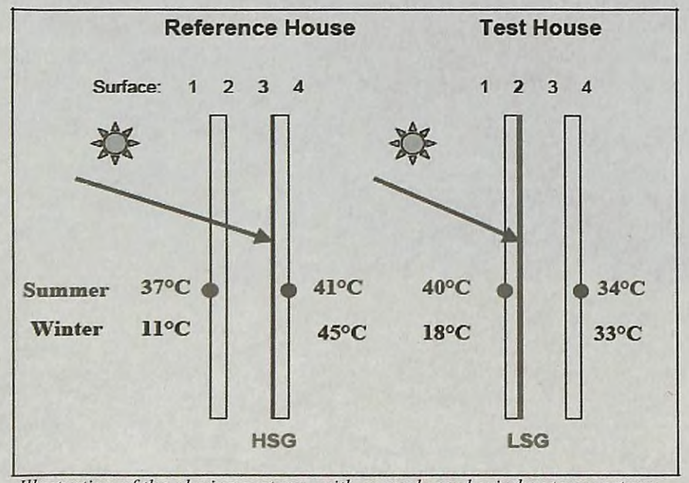


Illustration of the glazing systems, with example peak window temperatures on clear days in summer and winter

The glass in a double-glazed window has four surfaces, with the outside surface of the glass being one, and the interior surface being four. The performance of a double-glazed window will depend on the type of glass, the size of the gap, the nature of the low-e coating, as well as the location of the low-e coating.

Where low solar heat gain is desired to reduce overheating and cooling needs, the coatings are applied on surface 2. In those areas where high solar heat gain and heat retention is desired, the coatings are applied on surface 3.

Unlike other building materials, windows are transparent so they permit radiant energy flows through them. These energy flows can be in two directions, inward and outward, depending on the time of day and solar conditions. Depending on location of the house and its design, solar gains can typically range from 10% to 27% of total energy requirements for the house. During the summer months, excessive solar gains through windows will add to cooling loads.

Window products available today generally have much better insulating values, but can also have lower solar heat gains. The actual solar heat gain through the glass is greatly affected by the solar/optical characteristics of the coating on the glass. The low emissivity coating on glass used today is mostly effective during cold periods when the infrared radiation within the house is kept inside. However, there is a wide range of glass product on the market. It may be necessary to pay more attention to the properties of the glass itself.

Proper selection of the coated glass may have different impacts during the heating and cooling seasons. Glass manufacturers now make several types of coated glass intended to provide a wide selection of spectrally selective glass. The most notable difference between the windows is their ability to transmit solar radiation. In most cases, the thermal performance characteristics of these glazing units and their effect on the heating and cooling loads in buildings are based on computer simulations with limited field experiments to verify or validate their effect on whole-house heating and cooling.

How large an effect can changing the glazing system's solar heat gain characteristics have on the overall energy consumption of a house? A monitoring study done at the Canadian Center for Housing Technology (CCHT) at the National Research Council in Ottawa has shown that the use of low solar transmission glazing systems can increase the gas consumption by about 8.7% when compared to its performance with the high solar transmission glazing. In addition, the electrical consumption also increased by about 1.3% because of the reduced solar heat gain during the monitoring period.

The CCHT has two R-2000 houses that are side-by-side, fully instrumented and very nearly identical in every aspect. Two sealed double-glazed, low-emissivity insulating glazing systems (with different solar transmission properties) were evaluated. During the four-week winter monitoring period the natural gas and electricity consumption and air and window surface temperature measurements were recorded and analyzed.

The base case benchmarking of the two houses was done using a high solar transmission, low emissivity coating on surface 3 of all double-glazed, argon-filled windows and patio doors in both houses. Then, all glazing units in the test house were replaced by windows with a low solar transmission, low-emissivity coating on surface 2 of double-glazed argon-filled windows.

On January 26th, the data showed that only 40% of the total solar radiation incident on a wall was getting through the low solar heat gain (LSG) low-emissivity window. At the same time, 60% of the incident solar radiation was transmitted by the high solar heat gain low-emissivity (HSG) window.

Surface window temperatures are also affected by the choice of low-emissivity glass, and this too has an effect on space heating loads. The hotter window surfaces resulting from absorbed solar gains radiate heat inward, thus contributing to the reduced gas consumption.☼

Field Assessment of the Effect of Different Spectrally Selective Low Emissivity Glass Coatings on the Energy Consumption in Residential Application in Cold Climates *by Mike Swinton, Marianne Manning, Hakim Elmahdy, Anil Parekh, Chris Barry, Frank Szadkowski*
Paper presented at the 11th Canadian Conference on Building Science and Technology, Banff, 2007.

Building Envelope Guide for Houses

A new, easy-to-use Guide provides practical information on the design and construction of the building envelope for new homes constructed in accordance with Part 9 of the 2006 British Columbia Building Code (BCBC).

The Guide recognizes the complex ways that moisture influences building envelope durability and performance in the range of climate zones found in BC. It helps builders, designers and trades to put into practice the new Part 9 code requirements, including that for a rainscreen in houses built in coastal or high moisture index regions.

A brief discussion of fundamental building science principles reviews solid, liquid and vapour moisture sources and their impact on house construction. The discussion and details are based on current building science principles and building code requirements that have been and continue to be, explored by industry groups and professionals. This provides a context for the details that are presented, which include below grade and above conditions.

The above grade details show three air barrier options: the conventional polyethylene interior air and vapour barrier, the air-tight drywall (ADA) approach, and the exterior housewrap air barrier approach. Each detail is presented not as a typical working drawing graphic, but rather as a full colour 3-D image that was developed by computer graphics. Each detail has up to a dozen illustrations, showing the sequence by which that detail is put together.

Below grade details include full basement, crawlspace and slab-on-grade assemblies, and include a variety of insulation options. Above grade details include sheathing, wall requirements, rainscreen, various claddings, air barriers, and details. Details show how to comply with code minimums, as well as improvements beyond code minimums.

The development of the Building Envelope Guide for Houses was co-funded by the Homeowner Protection Office (HPO) and the Building Policy Branch, Office of Housing and Construction Standards and published by the HPO.

Building Envelope Details Guide - Part 9 Residential Construction *is available for $55.00.*
www.hpo.bc.ca follow links to what's new
Fax 604-646-7051
Toll-free 1-800-407-7757.

Energy Efficiency Upgrade Incentives

Renovators should be aware that the Ontario government has created a Home Energy Retrofit Program that provides homeowners with grants of up to $5,000 for home energy improvements. This amount is in addition to the $5,000 that could be available from NRCan through the ecoEnergy Retrofit program.

In order to qualify, the homeowner must have an ecoEnergy audit done. The homeowner has 18 months to complete the work recommended by the energy advisor in order to qualify for the incentives. A follow-up audit is done to confirm the energy efficiency upgrades before the formal application for incentive grant is made. In addition to the government grants, the Ontario Power Authority as well as gas utilities may offer some incentives.

The rationale for the incentives is that energy efficiency upgrades to existing homes can be expensive. Unlike new construction -- where energy efficiency upgrades are a matter of making a decision on specifications which generally involve little disruption – changes in existing homes may involve significant disruption and be difficult and costly to implement. Often, a special effort may be required to motivate homeowners to take action. When major renovations are being undertaken, energy upgrades may be easier to accommodate.

The Ontario incentive package should be attractive enough to encourage homeowners to take substantive energy improvements. Renovators and heating contractors in Ontario should keep these incentives in mind when dealing with new projects, as they offer an excellent way to help homeowners to upgrade the energy efficiency of their homes.

Outside of Ontario, only NRCan's ecoEnergy incentives apply, although some local utilities and agencies may have their own incentive programs that could be tapped.

The ecoEnergy Retrofit program is the newly reincarnated Energuide for Houses program recently revived by the federal government.

Information: *www.energy.gov.on.ca* (look for conservation home retrofit).

EcoEnergy Retrofit Incentives

ecoEnergy Retrofits, the federal government's revived Energuide for Houses program, has changed the way incentives are calculated. Rather than offering an incentive based on the energy performance improvement of a home, as calculated by the improvement in the Energuide rating, the incentives are offered based on specific actions taken, although they are scaled based on energy improvement.

We are listing a selection of incentives available. A full listing appears on the NRCan web site

http://oee.nrcan.gc.ca/residential/personal/home-improvement.cfm

For new construction there are some limited incentives offered by provincial and local agencies. Access can be had through the NRCan web site:

http://oee.nrcan.gc.ca

ENERGY STAR® qualified gas furnace that has a 92.0% AFUE or better, and a DC variable-speed motor	$500
ENERGY STAR® qualified oil or gas boiler that has an 85.0% AFUE or better	$600
CAN/CSA-C448 compliant ground- or water-source heat pump	$3,500
ENERGY STAR® qualified air-source heat pump	$400
Solar domestic hot water system that meets CAN/CSA Standards.	$500
Replace domestic hot water heater with an instantaneous gas water heater that has an energy factor (EF) of 0.80 or better	$200
Drain-water heat recovery (DWHR) system. Grants are based on the length of the pipe installed. For one that is at least 1 metre long	$100
Replace windows and skylights with ENERGY STAR® qualified for climate zone	$30 per unit replaced
Replace toilet with low-flush or dual-flush toilet rated 6 litres per flush or less that meets the Los Angeles Supplementary Purchase Specification (SPS) and with flush performance of 350 grams or more. Product list is available on the Veritec Consulting Inc. Web site at *veritec.ca*	$50 per unit replaced
Insulation upgrades vary on amount of insulation upgraded, and the percentage of area that is insulated. *For example, an existing ceiling with R-20 insulation qualifies for $300 if the full ceiling area is upgraded to R-50. If at least 40% of exterior wall area is upgraded with at least R-4, it would qualify for $360.*	

Impact of Moisture on Drywall Performance

In commercial buildings, gypsum board sheathing is used regularly because it is non-combustible. There will likely also be more interest in its use on low-rise residential projects because of the fire resistance protection it provides, especially for buildings with vinyl siding. Although gypsum board sheathing by itself is not structural, the Building Code gives some credit for gypsum sheathing in providing shear strength.

Gypsum board can hold a substantial amount of moisture -- up to 200% of its weight in water. This can damage water-sensitive components next to the sheathing (e.g. wood or metal framing), however, there is little information about acceptable levels of moisture content for gypsum-based sheathing products and on the consequences of exposure to moisture in terms of mechanical properties and the integrity of the wall assemblies.

A CMHC-sponsored project by Levelton Engineering looked at the mechanical properties of gypsum-based sheathing products with varying levels of moisture content.

The study found that handheld moisture meters (i.e., those that have a separate scale for gypsum) are reasonably accurate for paper-faced gypsum sheathing up to a moisture content of approximately 6%, which is within the normal range of performance for paper-faced gypsum sheathing products. Above that level the moisture meters read lower than the actual value. This study also confirmed a strong correlation between moisture content and the mechanical properties of various types of gypsum sheathing.

Test results suggest that the mechanical properties of gypsum sheathing would not meet current ASTM standards (C1177 for exterior grade gypsum, C1396 for fiber-faced gypsum) with moisture-content levels above 1%. However, there is some question as to whether the ASTM Standards are appropriate indicators of in-service performance (this is noted within the Standards), as some specimens tested did not meet the criteria even when oven-dry.

When gypsum board specimens were wetted and re-dried, the resistance to flexural loading of the fiber-faced gypsum sheathing essentially recovered its original values. Exterior grade gypsum sheathing recovered to approximately 94% of their original values, except where the facer-to-gypsum adhesion was lost (in that case, the resistance to flexural load was found to be 66% of the original value). The resistance to fastener penetration of all sheathing tested did not appear to be affected by wetting, once the specimens were dried out.

The 5/8" exterior grade sheathing never dried out, and only reached 1% moisture content after several days of drying in the oven. In general, the fiber-faced specimens appeared to take less time to take on water and less time to dry out. Mould developed on all the paper-faced samples.

In general, gypsum sheathing intended for exterior use should not be exposed to sources of moisture that will result in moisture content levels above 1% (as a percentage of dry weight). Gypsum sheathing that experiences moisture levels above 1% can be rehabilitated to some extent if the gypsum is carefully dried in such a way that the bond between the facer and the gypsum core is not disturbed.

Additional research would be useful to investigate the effect of prolonged high moisture-content levels on the strength of different types of fasteners and framing components. ☼

Relationship between Moisture Content and Mechanical Properties of Gypsum Sheathing – Phase 2 Research *by Alex McGowan. Paper presented at the 11th Canadian Conference on Building Science and Technology, Banff, 2007*

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Energy Answers

Rob Dumont

Do you have any advice to the Net Zero Energy (EQuilibrium) teams regarding how to truly achieve the ambitious goal of annual Net Zero Energy consumption?

Here are some hard-learned lessons from other demonstration projects that I have been involved with.

1. Commissioning

Carefully check all the equipment that is used in the house. Most heating equipment in houses is not commissioned. As one furnace installer once told me, "Hey, if there is heat coming out of the furnace and it doesn't trip on the high limit, I am outta there. I'm not paid to do anything more." Most of the Net Zero houses are using either active solar heating systems, heat pumps, or both. In addition, the houses will have both a heat recovery ventilator (air-to-air heat exchanger) and a photovoltaic system. These systems are not like electric baseboard heaters, where almost nothing can be screwed up.

An active solar system must be carefully commissioned. My approach with equipment is to regard every sensor as guilty until proven innocent.

Are the thermistor sensors calibrated and installed properly on the thermostatic controller?

Are the flows through the collectors in the right range?

Does the heat storage tank have copious amounts of insulation? If the tank does not have at least R30 insulation it likely needs more.

Are all lines carrying hot fluids well-insulated?

Does the back-up heating system only work when needed, or can it trip on with no one noticing?

Does the solar system have a potential to siphon off stored energy at night? Has the system been checked out for back thermosyphoning?

These kinds of equipment checks are not achieved with a casual look.

Heat pumps are not simple.

Is the refrigerant charge in the heat pump exactly right?

Is the amount of superheat in the right temperature range?

Are the heat exchanger coils on the evaporator and the condenser clean and operating properly?

Is the thermostat able to properly provide heating (and cooling, if provided)?

Was a high efficiency motor used on the warm air fan for the heat pump?

Was a low pressure-drop air filter used? A low pressure-drop filter offers less resistance to air flow which means less horsepower is needed to circulate air.

Are the backup resistance heaters in the heat pump properly set up so that they only come on as a last resort?

Have the heat recovery ventilator airflows been properly set with flow grids and manometers? Does the installer know what air flow is required? Has a balancing report been done?

Will the HRV run on high speed continuously? (It should not.)

Does the defrost cycle work properly and has it been tested on site?

Are the right air filters installed?

Are the proper bird screens used on the inlet and outlet ducts for the HRV?

Have the ducts been properly sealed with foil tape or mastic?

Are the flexible, insulated ducts properly attached on either end?

The photovoltaic system should have a meter or meter indicating how much energy is being collected.

One of the characteristics of all the above systems is that the house will function more or less even if the system has failed or partially failed. This is good from a reliability standpoint, but not good from an energy efficiency standpoint.

2. Simple Instrumentation

Include some simple devices that can indicate to the occupants whether the systems are running properly. It is my understanding that most of the houses will ***not*** have data loggers and other specialized instrumentation. At a minimum, I would recommend that the following instrumentation be included.

For an active solar heating system: digital temperature sensors should be mounted on the storage tank and at the solar collector outlet. Electricity meters, preferably digital, should be installed to indicate the amount of backup heat needed for space and for water heating.

For a heat pump: an electricity meter should be included that monitors how much backup heat is being provided by the electric resistance heaters.

For the heat recovery ventilator: flow grids hooked up to manometers should be used on each of the two airflows. The correct low speed airflow should be marked in bold letters on or near the manometers. Magnehelic gauges are much better for this purpose than oil-filled gauges.

For the photovoltaic system: some simple instrumentation such as an ammeter or wattmeter should be included to indicate the output.

Each of the 120-volt white appliances should have a digital meter such as a Kill-A-Watt to indicate the electricity consumption, and the measured short-term values should be checked against their ENERGUIDE ratings.

3. User-friendly whole house energy monitoring

Include some simple instrumentation to allow the homeowner to follow how much overall energy is being used. A previous *Energy Answers* column (Solplan Review, November 2006) had information on the Powercost Monitor and The Energy Detective units which will provide an instantaneous measurement of electricity consumption. At a cost of less than $200, these instruments will likely be the single best instrumentation investment made for the homes.

4. Education

Educate the occupants. Let me repeat in capital letters -- EDUCATE THE OCCUPANTS. Even the cheapest automobile these days has a 100-page plus manual to explain the operation. Prepare a user's manual for the house, and go through the manual with the occupants at the time they move in. Show them the operation of all the innovative equipment and what to look for.

5. Analyze data early on

Don't wait for the end of the one-year monitoring period to start analyzing the data. For example, have an estimated energy consumption value for each month of the year for the house, and make the homeowner aware of how to read the meters and compare their performance against that of the prediction. Sprinters run faster when someone is watching.

6. Phantom electrical loads

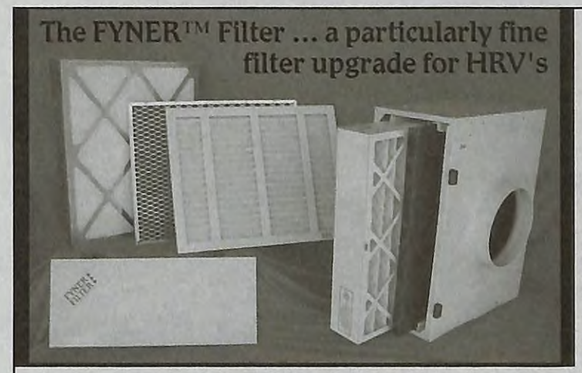
Be very careful about phantom electrical loads-- those pesky electrical loads that occur even when a piece of equipment is nominally off or not in use. Televisions, stereos, DVD players, satellite boxes, VCRs, cable TV modems, DSL modems, chargers for battery-operated power tools, idling computers and other similar equipment all can add to the house electrical load. Some studies have shown values in the range of about 500 kilowatt hours a year for an average year due to phantom loads. Use switchable power bars on all the above equipment.

7. Timeliness

Be on top of having all the equipment installed and commissioned before the occupants move in. Procrastination is never a virtue with a short-term demonstration project.

The EQuilibrium program for Net Zero Energy Homes is a world-class Canadian initiative. Using the above seven points should help achieve world-class performance.

These points are also useful for any building project, to improve its performance.☼



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NRC·CNRC

New field testing facility at NRC-IRC offers opportunities for wall performance assessment

By Wahid Maref and Madeleine Rousseau

The National Research Council's Institute for Research in Construction (NRC-IRC) has completed a major upgrading of one of its three research houses located on the Ottawa campus. As its new name suggests, the *Ventilation and Wall Research House* enables the conduct of research projects that integrate indoor climate and building envelope performance. The results have the potential to improve housing comfort, healthiness, durability and energy efficiency because the research projects can be designed to assess heat, air and moisture transfers between the outside, the enclosure, the indoor air and the HVAC systems. Previous issues of *Solplan Review* contain articles about projects on hybrid heating and ventilation systems being conducted in the facility.

An important component of this world-class test house is the wall-testing part, called the *Field Exposure of Walls Facility* (FEWF). This facility enables researchers to characterize the hygrothermal performance of innovative wall and window systems. It features a test bay 7.5 m wide by 3.2 m high that can accommodate three wall specimens, including a means to isolate each from one another. The test bay can be used to compare the performance of traditional and innovative lightweight or opaque wall specimens, as well as the performance of windows and the junctions between windows and walls.

The upgrading of the research house included the installation of sophisticated and innovative monitoring equipment capable of tracking indoor temperature, humidity and pressure; wall inter-spatial relative humidity, temperature, air pressure, wood moisture content and liquid water deposition; and outdoor temperature, relative humidity, pressure, rainwater deposition at the outside face of the exterior siding. Meteorological data is collected at a weather station near the research house.

This photo of the wall test facility shows some of the instrumentation being installed on the exterior of the sheathing board to monitor temperature, relative humidity, moisture content and water deposition on each of the three wall test specimens. Monitoring of these specimens started in Fall 2006 and will continue through Summer 2007.

The wall test facility allows NRC-IRC researchers to assess the hygrothermal performance of innovative wall and window systems relative to variable indoor conditions and relative to yearly weather cycles. It provides the ability to investigate the comparative performance of different side-by-side wall assemblies as well as the interaction between the building envelope and the indoor environment, under naturally fluctuating outdoor climate and controlled indoor conditions of relative humidity, temperature and pressure as defined by occupancy and HVAC systems. NRC-IRC will also be using research results from the wall test facility to fine-tune hygrothermal mathematical models it has developed (hygIRC 1D and 2D)

During the first year of operation (2006-2007), researchers implemented a project in the FEWF to investigate the wetting and drying potential of three traditional wood-frame wall assemblies when challenged with increased air leakage rates and increased indoor relative humidity in wintertime. For two of the test specimens the indoor relative humidity and air exfiltration levels were increased sequentially to examine condensation accumulation in different layers of the assemblies and to acquire valuable information on the assemblies' response. The third wall specimen was not challenged with these conditions, and thus, provided a reference basis for the changes in the other two specimens. In the spring, the drying potential of the test specimens was monitored. The data is being analysed and will be published soon.

This coming winter NRC-IRC researchers will investigate the effects of exterior energy retrofit strategies on moisture accumulation and temperature distribution in typical housing construction (2x6 with batt insulation, poly air/vapour barrier for air, heat and moisture control), using a test protocol aiming to challenge the wall assemblies with steps of increased indoor relative humidity and air exfiltration levels. It is expected to complement the testing done on wall tests specimens in 2006-07.

The Ventilation and Wall Research House vastly improves the ability to study innovative building technologies and provides an excellent opportunity for manufacturers and designers to test new products and technologies. Indeed, NRC-IRC is actively seeking partnerships with public and private agencies to investigate issues of heat and moisture flows across wall assemblies. For instance NRC-IRC researchers envision the potential of the wall test facility to advance building envelope science and performance assessment in the following areas:

- Innovative coatings and membranes developed to perform multiple hygrothermal functions at different times of the year (for example, smart vapour barriers).
- Vapour barrier, air barrier and heat flow control strategies for minimal wetting and maximal drying of wall assemblies over cycles of seasonal loading.
- Traditional or innovative insulation systems designed to provide thermal resistance and other functions (for example, insulations that also act as vapour and/or air barriers).
- Innovative wall or wall/window configurations designed for temperature and moisture control.
- Field benchmarking of the NRC-IRC envelope environmental exposure facility (EEEF), a complementary laboratory facility designed to mimic outdoor and indoor climate loading, and hygIRC numerical modelling software for building envelope optimization.

For more information about the Field Exposure of Walls Facility and partnership opportunities, visit the website:
http://irc.nrc-cnrc.gc.ca/bes/facilities/fieldex_e.html,
or contact Dr. Wahid Maref
(*Wahid.maref@nrc-cnrc.gc.ca*).

Wahid Maref and Madeleine Rousseau are research officers in the Building Envelope and Structure Program of the NRC Institute for Research in Construction.

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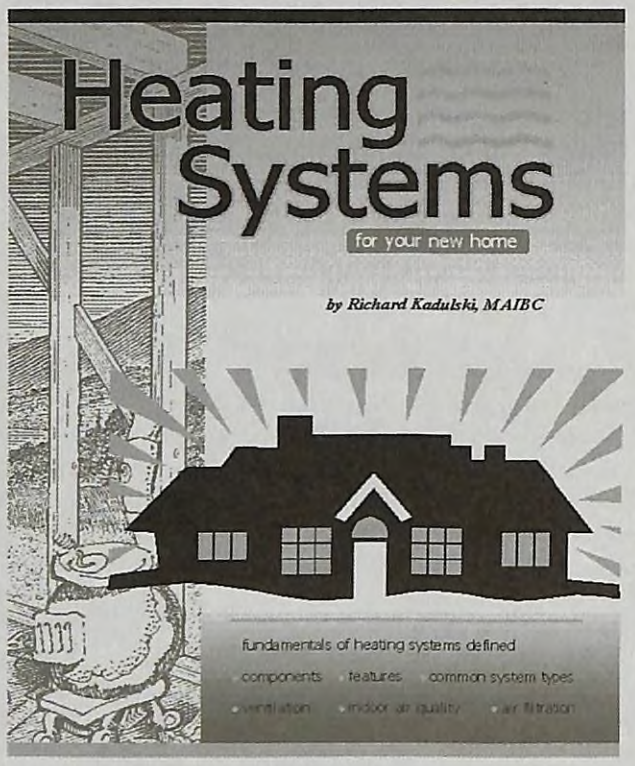

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Heating Systems for Your New Home is the book that explains heating system options for your new home.

Contents include:

- **Heating Fundamentals**
- **Heating System Types**
- **Features to consider**
- **Common system types described**
- **Overview of ventilation**
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- And much more!

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